ART. XXIX.—*Difference in the Climate of the Greenland and American sides of Davis' and Baffin's Bay;** by RALPH S. TARR.

Route followed.—During the summer of 1896, I made the journey along the Labrador and Baffin Land coasts, northward in the latter part of July and southward in early and middle September.† The period between these times was spent on the Greenland coast, the northernmost point visited being in lat. 74° 15′. Some features concerning the marked difference in climate on the two sides of the sea separating Greenland from the American land, apparently well known to Arctic voyagers, but new to me, have seemed to warrant brief statement.

Climate of American and Greenland sides.—On the northward trip a landing was made at the island of Turnavik, about in lat. 55°, on July 20. There extensive snow banks were found to be still lingering in the sheltered valleys, at points no more than one or two hundred feet above the sea level. Indeed several hundred miles to the south, on the west coast of Newfoundland, snow was seen. Later a landing was made in southern Baffin Land, on Hudson Straits, and here snow banks were also found. Nearly the entire distance traversed by the ship, from southern Labrador to the mouth of Cumberland Sound, one or two degrees south of the Arctic Circle, where we left the American coast, we met with floe ice, often so heavy that progress through it was slow and difficult. This was an unusual season, and hence the conditions were somewhat more severe than common. The ice is rarely so abundant at this season of the year. The presence of great floes, moving southward in the Labrador current, so chilled the air that the thermometer often stood in the thirties, and frequently descended to the freezing point. On July 30 snow fell in some quantity upon the ship, which then lay off Frobisher Bay.

On July 30 an unsuccessful attempt was made to enter Cumberland Sound, which was then, as often in this season of the year, completely shut in by the heavy ice floe. Not being

*It is a rather remarkable fact that the great bay which extends north to the Arctic circle, from the main Atlantic to Davis' Straits, should have been given no name. Baffin's Bay extends from Cape York to Davis' Straits at the Arctic circle; but no name is applied to the bay south of this. Because of the difficulty experienced in the attempt to write this article, on account of the absence of such a name, I would propose for the bay between Labrador and Greenland and south of Davis' Straits, the name *Davis' Bay* after the first navigator of these waters, who, in the year 1587, made the perilous voyage in a sailing vessel as far north as Upernavik.

† As a member of the Peary Greenland Expedition.

able to penetrate the ice, the ship left this bleak coast and crossed Davis' Straits to Disco island on the Greenland coast, going north four or five degrees. There we found a decided change in climatic conditions. The air was balmy, and although the highland portions of the mainland and island were ice-capped, and snow banks were seen in the protected valleys, the season was distinctly more advanced and more pleasant than on the American side two or three hundred miles southward. The flora was richer, insects were abundant, and everything betokened summer. Passing still farther northward to the Upper Nugsuak peninsula, in lat. 74° 10′, although the climate was somewhat more severe, it was distinctly farther advanced than on the American side which had been left a few days before, and which lay five or six hundred miles to the southward.

From August 7 to September 7, although by the latter date the night had begun, with the sun setting at about 7.30 in the evening, we were able to live comfortably in lat. 74° 10′ with no other protection than that of tents. During this time the lowest recorded temperature was 28°, which came at the coldest part of the night. The storms brought rain and not snow. Returning, we left Disco on September 11 after a beautiful, warm day. Snow had recently fallen upon the uplands, but many flowers were still in blossom near sea level. Coming southwards to the mouth of Cumberland Sound, our first view of the American land showed a snow-covered surface, and from this point to the north end of Newfoundland, freshly fallen snow was seen on the land.

Although we later found that the floe ice had disappeared from the Labrador coast, it still blocked a portion of the entrance to Cumberland Sound, and for sixty hours the ship was held a prisoner in this ice before we could pass into the Sound. After entering Cumberland Sound we encountered violent snow storms, and the fall of snow was sufficient to cover the surface of the land. Hence in this latitude, in the summer of 1896, snow fell on July 30 and on some day previous to September 13, the latter fall being sufficient to whiten the hills as seen from the sea.

Influence of Ocean Currents.—The causes for this difference between the climate of the two sides of a sea separated by only a few hundred miles in the broadest portions, are perhaps several, though the chief cause is to be found in the ocean currents. The icebergs and floes of the Arctic pass southward on the American side, and the cold ice-laden waters influence the climate of the neighboring land very perceptibly. On the Greenland side there is a current in an opposite direction, hence carrying warm water northward.

It is difficult to say how far the north-moving current

extends, and also how far from the land its influence is felt. I should say that the current does not probably reach far to sea; because if it did, the bergs and winter sea ice would not readily escape, and the Greenland coast would be ice-bound in summer, rather than ice-free as we found it.* There are some reasons for thinking that the north-moving current extends as far as the northern end of Melville Bay. The fact that great quantities of ice accumulate and remain there, rendering this bay notoriously difficult to navigate, seems to show that something interferes with the southward movement of the ice.

Pointing toward the same conclusion that the warm current reaches into Melville Bay, are the observations which were made from our camp at Wilcox Head, the point of the Upper Nugsuak peninsula which projects into Baffin's Bay near the southern end of Melville Bay. During two or three weeks encampment at this exposed point, it was noticed that the ice-bergs floated almost uniformly toward the north. It is true that this was a period during which south winds prevailed, but even when these did not blow, the bergs still moved northward. Moreover with but one hundred feet, or less, above the water, it seems improbable that the great ice masses which floated past our camp could have been driven so rapidly by mere wind action, particularly when the wind was not strong.

Influence of Winds.—There are two other reasons for climatic moderation on the Greenland coast; in the first place the winds from all directions, excepting the east, reach the shore from water, the temperature of which is well above the freezing point during the summer. The entire coast of this part of Greenland is then free from floe ice, and is encumbered only with scattered bergs and berg fragments. Hence on this coast the water is warmer than that on the opposite side of Baffin's Bay. On the one shore there is a cold ice-laden current, on the other a slowly moving drift of water *toward* the north. One might expect that the wind blowing from the ice cap of Greenland, the prevailing wind while we were there, would be cold; but the reverse is true. This wind, descending from great altitudes and passing over the surface of snow and ice, is really warmer than that from the sea, and at times it was

* Incidentally I would call attention to the fact that this clearing of the various forms of ice from the Greenland coast is usually made possible by the winds that blow from the ice cap It is an interesting coincidence that the very cause for most of the ice gives rise to conditions which permit this to be carried away. From the cold highland area of inland Greenland, the dense air settles and blows outward, producing off-shore winds, which keep the fjords free of ice encumbrances; and at times, extending out from the coast, the wind drives this ice well to sea, where it comes under the influence of the south-moving currents, which I believe must exist not far from the Greenland shore.

noticeably warm, rapidly descending air. The explanation is no doubt the same as the explanation of the chinook and foehn winds.

Cause of difference in Glaciation.—On the Greenland side the land is mainly submerged beneath the great ice cap, with branches extending to the sea through the valleys. On the American side there are only a few isolated glaciers on Baffin Land, and none are known to exist in Labrador. On the American side the southernmost glacier is located on the southern side of Frobisher Bay in lat. 62°. It is evident that this difference in ice-covering is not due to the climate near the coast line, for a much greater development of glaciers is found on the side where the climate is more moderate. Possibly one of the causes for the difference is the greater humidity of the air that comes to Greenland after crossing over the waters of Baffin's and Davis' Bays; but the main cause for the difference is evidently the greater elevation of the land on the eastern side.

*Former Glaciation on the American side.**—Labrador and Baffin Land have been recently glaciated. So recent was this time of glaciation that at Turnavik Island, on the Labrador coast, glacial striæ still remain distinctly on the exposed rock-faces. The violent frost action on Baffin Land has in most cases removed the striæ; but the form of the hills, and the presence of erratics on the surface, show recent glaciation. Comparing the conditions seen here with those of New England, it seems certain that the glacier has left this northern region more recently than New England.

Changes in Level of Baffin Land.—Before the ice covered this land it was much higher than now. The evidence of this is as striking as that on the coast of Maine. The land valleys are in all stages of submergence; in Hudson Straits there are entirely submerged strike valleys, others into which the sea enters, and still others entirely above the sea level. The fjords, the nearly land-locked bays and sounds, and the land valleys extending beneath the sea, make this coast one of the most irregularly indented shores in the world. It is possible to navigate for fifty miles behind the land on the southern side of Cumberland Sound, being all the time behind hills which reach five hundred or a thousand feet above the sea.

It is practically certain that the glacial conditions came when this land was higher. When the ice disappeared the ancient highland was reduced in elevation, and the level of the hills was lowered three or four hundred feet below the surface of the sea, for beaches are found at this elevation, in various parts of

* Tarr, Am. Geol., 1897, xix, 131 and 191.

Baffin Land.* Perhaps in this depression is found a potent cause for the disappearance of the ice sheets.

Now the American land is engaged in the reverse movement of uplift. It stood three hundred feet lower at a time so recent that the boulder beaches are distinctly visible, and the individual boulders scarcely injured by the action of the weather in this region of extremely violent frost work. Their surfaces bear lichens, but they are still rounded, and they lie directly on the surface, with scarcely any soil accumulation since they became a part of the dry land. Very recently this land was moving upward, for there are beaches directly above the present ones, and yet so closely connected with them that at first it seemed that they must be forming even now. This is in harmony with the evidence obtained by Dr. Bell on the shores of Hudson's Bay.

Relation of Changes in Level to Glaciation.—Elevation is a potent cause for glaciation. Baffin Land and Labrador have been glaciated in a recent period, during a time when the land stood a thousand feet or more above the present level. The ice of this period disappeared when the land was lowered, and possibly *because* it was lowered. Now the land is rising: at present the climate is so rigorous that even with the present elevation the conditions are nearly severe enough for glaciers to develop, and in some places they do actually exist. Even near the sea level the snow banks do not disappear before the first of August, and snow commences to fall in the autumn as early as the middle of September. So far as I can estimate from my short visit, it seems that there must be places not far above the sea level where even now the snow stays throughout the summer. A slight change in climate is all that is needed to increase the number of these, and to add to their area and depth until glaciers begin. The elevation needed for this increased rigor cannot be many hundred feet in the higher regions.

Such elevation, if widespread (and the recent uplifts have extended over a broad area), would remove another of the causes for moderation in this northern climate, namely the disappearance of some of the neighboring water: the recent uplift in Baffin Land has added a large amount of land to the former area, even though the elevation has been only about three hundred feet. This uplift has so decreased the depth of some of the bays and straits that an additional elevation of three hundred feet would very perceptibly reduce the amount of water both north and west of Labrador. This added land

* The question of the elevated beaches of Baffin Land is discussed by Mr. T. L. Watson in a paper published in the Journ. of Geol., 1897, v, 17.

and decreased water area would increase the rigor of the climate.

The point which I wish chiefly to make is that the climatic conditions of Baffin Land and Labrador are wonderfully near those which produce glaciation. I would not predict that these lands are about to enter into a glaciated condition again, but it is safe to say that if the elevation now in progress continues, the time is not far distant when valley glaciers will again come in the Labrador peninsula and when those of Baffin Land will increase in extent, provided of course that there are no general changes of climate in progress, the nature of which we do not understand. From this condition of local glaciation to a general ice sheet, spreading over the land, the step is not great.

While upon this topic, and in conclusion, it may be pointed out that in addition to the moderateness of the summer climate of the Greenland coast, there is also a submergence of the land at present in progress. Topographical evidence of this is plain in the places which I visited, and the Danes have proved the point for at least some portions of the coast. Accompanying this subsidence, the Greenland glacier has recently withdrawn, at least from the land of the Upper Nugsuak peninsula, and the amount of withdrawal has been great indeed. Even now the ice-front at this point is moving backwards.

Is Greenland now passing through the stage of ice-withdrawal from which the American, Labrador and Baffin Lands have so recently escaped? and is there any relation between the down-sinking of Greenland and the uprising of Labrador and Baffin Land? Is the ice-withdrawal directly due to the land movement, and is the load of ice really the cause for the sinking which allows its withdrawal? that is, does the ice increase in area and extent with no other result than its own destruction by depressing the land, and hence removing the cause of supply? These questions very naturally arise and others even more speculative come to mind; but as their answer is not definitely at hand they may well be left as mere queries.

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